VINES OF A TEMPERATE STATE: STILL UNDERCOLLECTED?

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ABSTRACT

Over the past decades, there has been a steady effort to contribute to our knowledge of herbaceous and woody vines (lianas)—a habit previously largely neglected in both botanical and ecological studies. This study sought to evaluate to what extent progress has been made in our floristic understanding of lianas and vines in a state hosting the highest number of herbarium specimens per square mile in the southeastern United States—North Carolina. To analyze the state of our floristic understanding, baseline and updated county species lists of lianas and vines were developed based on literature review and herbarium survey. To compare liana and vine species richness by ecophysiological province, an index of species similarity was calculated. The Piedmont and Coastal Plain host the largest absolute number of vine taxa in North Carolina, as well as the largest mean richness per county. The higher Piedmont mean richness may be due in part to geographic position and overlapping distributions from adjacent provinces. However, reasons for the particularly high species richness of individual counties and the significant variation in county to county species richness remain unclear. Macro-climate, as well as diversity in topography and associated microclimate may be factors. However, the three most species rich counties also happen to host the three largest herbaria in the state, suggesting the potential influence of historically larger collecting programs. Other non-biological factors potentially involved include distance to site and accessibility.

RESUMEN

En las décadas pasadas, ha habido un esfuerzo constante para contribuir a nuestro conocimiento de las lianas herbáceas y leñosas—un hábito previamente muy descuidado tanto en los estudios botánicos como ecológicos. Este estudio pretendió evaluar en que medida se ha progresado en nuestro conocimiento florístico de las lianas en un estado que alberga el mayor número de especimenes de herbario por milla cuadrada del sureste de Estados Unidos—Carolina del Norte. Para analizar el estado de nuestro conocimiento florístico, se desarrollaron listados de especies por condado, básicos y puestos al día, de lianas basados en revisiones bibliográficas y de herbarios. Para comparar la riqueza de especies de lianas por provincia ecofisiológica, se calculó un índice de similitud de especies. El pie de monte y la llanura costera tienen el mayor número absoluto de lianas de Carolina del Norte, así como la mayor riqueza media por condado. La alta riqueza media del pie de monte puede deberse en parte a la posición geográfica y a las distribuciones solapadas de las provincias adyacentes. Sin embargo, las razones para la riqueza en especies particularmente alta de condados individuales y la variación significativa de condado a condado no quedan claras. El macroclima, así como la diversidad en topografía y el microclima asociado pueden ser factores. Sin embargo, los tres condados más ricos en especies tienen también los tres herbarios mayores del estado, lo que sugiere la influencia potencial de los programas de colecta históricamente más amplios. Otros factores no biológicos potencialmente implicados incluyen la distancia al lugar y la accesibilidad.

An important aspect of recent studies of vines has been the exploration of the underlying causes determining and limiting the distribution of species and

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individuals (Bell et al. 1988; Molina-Freaner & Tinoco-Ojanguren 1997; Castellanos et al. 1999). Understanding factors controlling vine distributions is of interest in understanding broader patterns of vine species richness. Several factors, such as soil moisture (Bell et al. 1988; Collins & Wein 1993), availability of small diameter supports (Putz & Chai 1987), distribution and spatial arrangement of supports (Putz & Chai 1997), as well as preferences for light microenvironments within host canopies (Castellanos et al. 1999), have been found important, but further study is warranted before a synthesis can be obtained. Although lianas and vines have been previously largely neglected in both botanical and ecological studies (Jacobs 1976; Putz 1984; Gentry 1991; Collins & Wein 1993), there has been a steady effort over the past decades to contribute to our floristic knowledge base of this important group. Gentry (1991, 1995) reviewed the floristics of lianas as determined from a series of 0.1 ha plots mostly located in Neotropical lowlands or Andean montane sites. Work by Grubb et al. (1963), Putz (1983, 1984), Collins and Wein (1993), Burnham (1997), and Krings (2000a, 2000b, 2001), among others (see Putz & Mooney 1991), has also contributed to our understanding of New World lianas and vines. This study sought to evaluate to what extent progress has been made in our floristic understanding of lianas and vines in temperate North Carolina. With the highest number of herbarium specimens per square mile in the southeastern United States (Funk & Morin 2000), North Carolina presents an interesting situation for evaluating the status of collections of this historically undercollected group.

METHODS

To analyze the state of our floristic understanding, baseline county species lists of herbaceous and woody vines [hereafter collectively "vines"] were developed based on Radford et al. (1968). Separate, updated species lists were then developed based on literature review (Kessler 1956; Gupton 1960; Morgan 1962; Sears 1966; Blair 1967; Tucker 1967; Bruton 1968; Hartshorn 1968; Sawyer 1968; Michael 1969; Pittillo et al. 1969; Pultorak 1969; Wells 1970; Jones 1971; Pittillo et al. 1972; Jones 1973; Taggart 1973; Taylor 1974; Racine & Hardin 1975; Smith 1977; Lacey 1979; Corda 1982; Skean 1982; Rohrer 1983; Sieren 1983; Mayes 1984; Bradshaw 1987; Pittillo & Brown 1988; Matthews & Mellichamp 1989; Palmer 1990; Ingle 1993; Floyd 1997; Strickland 2000), as well as herbarium searches at NCSC and NCU. All climbing, woody and herbaceous taxa known from North Carolina are included. Prostrate, mat-forming taxa, such as *Mitchella repens* L. (Rubiaceae), are excluded.

To compare vine species richness by ecophysiological province, an index of species similarity was calculated based on a modification of Sørensen (1948). As area has been shown to significantly influence species richness (White et al. 1984; Kohn & Walsh 1994), the Sørensen index is most precise when two communities of the exact same size are compared (e.g., using fixed area

transects). When communities of different sizes are compared a modified index can be calculated:

$$\text{(Eq. 1) Index of similarity (area-weighted)} = \frac{C/\log \text{area}_A + C/\log \text{area}_B}{A/\log \text{area}_A + B/\log \text{area}_B} * 100,$$

where C is the number of species shared between two respective sites, and A and B are the numbers of species present at each respective site. Although not as precise, non-modified Sørensen indices have been used between communities of different sizes (see Sklenář & Jørgensen 1999) but should be interpreted cautiously for revealing broad trends in similarity.

RESULTS

Including escaped and persisting taxa, the North Carolina vine flora currently comprises 155 species in 31 families.

Over the period of 1968–2001, the largest percentage of new North Carolina county vine species presence records came from the Mountain and transitional Mountain-Piedmont counties (Table 1). Except for Wilkes County (no change), all Mountain counties showed an increase in the number of vines known from 1968 to 2001. County records of Piedmont, Piedmont-Coastal Plain transition, and Coastal Plain counties, increased only a third or less (by percent) of Mountain record increases (Table 1). Nine of the 31 Piedmont counties showed negative changes in the number of vines known over the period. Nine Coastal Plain counties also showed negative change over the period. Negative change resulted from changes in taxonomy or resolution of formerly mis-applied names. No change in the number of species known occurred in 20 of the 100 counties of North Carolina. Thus, 38% of all counties displayed either a negative change or no change in the number of species of vines known in 2001 vs. 1968.

Based on the updated 2001 data, Piedmont counties host a significantly higher mean number of species ($x = 40.7$) than do Mountain counties ($t = 5.140$, $p < 0.0005$) or Coastal Plain counties ($t = 4.283$, $p < 0.0005$). Coastal Plain counties also host a significantly higher mean number of species ($x = 37.1$) than Mountain counties ($x = 35.5$; $t = 1.785$, $p < 0.025$). The Piedmont and Coastal Plain host the largest absolute number of vine taxa in North Carolina (Table 2), as well as the largest mean richness per county.

DISCUSSION

The higher Piedmont mean vine species richness may be due in part to geographic position. Piedmont counties host a larger percentage of vines overlapping in distribution from adjacent provinces than Mountain or Coastal Plain counties. However, reasons for the particularly high richness of several, scattered counties remain unclear (Fig. 1).

TABLE 1. Changes in liana and vine species totals known per county in North Carolina 1968–2001.

	Avg. no. of spp. per county (1968)*	Avg. no. of spp. per county (2001 update)	Change in spp. nos. 1968–2001	Percent change in spp. nos. 1968–2001
Mountain counties (N=20)	30.7	35.5	+ 4.8	+ 15.6
Mountain-Piedmont transition counties (N=5)**	29.2	35.0	+ 5.8	+ 19.9
Piedmont counties (N=31)	38.6	40.7	+ 2.1	+ 5.4
Piedmont-Coastal Plain transition counties(N=3)***	43.0	45.0	+ 2.0	+ 4.7
Coastal Plain counties (N=41)	35.8	37.1	+ 1.3	+ 3.7

* Based on Radford et al. (1968).
** Alexander, Burke, Polk, Rutherford, and Surry counties.
*** Lee, Moore, and Richmond counties.

TABLE 2. Matrix of Sørensen's indices of similarity (area-weighted) for the vine flora of North Carolina by physiographic province. Diagonals indicate total number of liana and vine species and, in parentheses, number and percentage of included, introduced liana and vine species.

	Mountains	Piedmont	Coastal Plain
Mountains	**89** (20; 22.5%)	–	–
Piedmont	75.16	**111** (35; 31.5%)	–
Coastal Plain	65.03	82.13	**118** (36; 30.5%)

Note: Transitional counties of overlapping physiographic provinces are not considered in the table. These counties are Alexander, Burke, Lee, Moore, Polk, Richmond, Rutherford, and Surry.

It is possible that richness in some counties, particularly in the eastern Piedmont, may be linked to macro-climate, as well as diversity in topography and associated microclimate. For example, Hardin and Cooper (1967) suggested that eastern Piedmont communities (especially in Durham, Orange, and Wake counties) are particularly rich in plant taxa (of all habits) due to a significant mountain and mountain disjunct element in their flora. Citing growing season and precipitation data, Hardin and Cooper (1967) provide indirect support for their hypothesis that this component of the flora is largely remnant from Pleistocene times and persists in cooler microsites. Topographically more highly dissected than the western Piedmont, the eastern Piedmont may provide a higher number of sites amenable to the occurrence of montane elements (Hardin & Cooper 1967), although further studies are needed.

Although Hardin and Cooper (1967) discount montane disjunction patterns as an artifact of sampling, the same may not yet be defendable for the distribution of vine taxa. As Connor and Simberloff (1978) have explored, in some

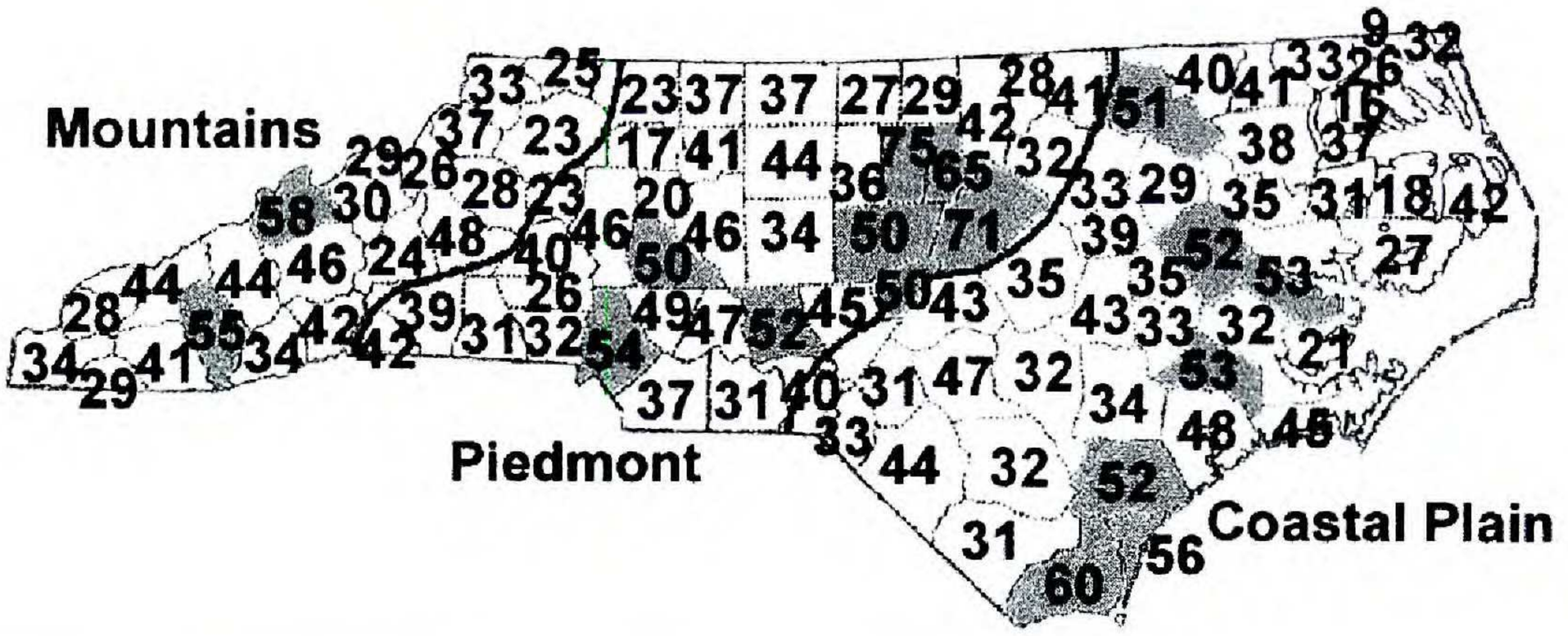

FIG. 1. Liana and vine species richness in North Carolina by county (based on Radford et al. (1968) and updated through literature review and search of herbarium collections of NCSC and NCU). Counties with 50 or more species are shaded gray.

instances collection effort may be a greater indicator of species richness and similarity among communities than biological factors. Based on our present knowledge, county to county vine species richness varies so generously within North Carolina provinces (Fig. 1) that an analysis of variance (ANOVA) found no significant difference by province in county species richness ($F_{0.05;\ 2,\ 91} = 1.355 < F_{crit}\ 3.098$; $p > 0.26$). Such variation is unexpected based on distinct differences in the climates and soils of the state's three provinces (Robinson 1979) and suggests non-biological causal factors. Potentially the result of historically larger collecting programs, the three most species rich counties also happen to host the three largest herbaria in the state (DUKE, NCU, and NCSC) (Fig. 1). Distance to the study site from the residence of researchers could likely influence the number of visits and hence the completeness of inventories. Accessibility and topography could also play a limiting role. Combined with less than 5.5% growth in county records for 75% of the potentially most speciose North Carolina counties (i.e., Piedmont and Coastal Plain counties) over the past thirty-three years (Table 1), the encountered county to county species richness variation indicates that, at least geographically, vines still remain largely undercollected for much of North Carolina.

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